
ENVIRONMENTAL Fact Sheet



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ARD-EHP-29

2009

Vinyl Chloride: Health Information Summary

Vinyl chloride is colorless, sweet smelling, and generally a gas at ambient temperature since the pure substance changes from a liquid to a gas when the temperature reaches 8° Fahrenheit. About 98 percent of it produced is used to make polyvinyl chloride (PVC), a plastic that is manufactured into a variety of products including automotive parts, plastic pipes, furniture, construction materials, and electrical wire insulation.

The majority of environmental releases of vinyl chloride occur via the air during the production of PVC. Environmental releases to surface water are expected to vaporize into the air within hours. Vinyl chloride vapors in the air are expected to be degraded within a few hours. Because vinyl chloride does not bind to soil nor is it biodegraded by soil microorganisms, it will readily migrate to groundwater where it can remain for months to years. Some of the vinyl chloride present in groundwater is due to the fact that it is an environmental breakdown product of the commonly used solvents trichloroethene (TCE), tetrachloroethene (PCE), and 1,1,1-trichloroethane.

The odor threshold for vinyl chloride in air is reported as 3,000 parts per million (ppm); its odor threshold in water is 3.4 ppm.

Health Effects

Absorption/Metabolism

In one study, human absorption from inhalation exposure to vinyl chloride was about 40 percent. In a rat study, oral absorption of vinyl chloride was about 95 percent. There is no information on absorption from dermal exposure; however, it is not expected to be significant compared to oral and inhalation absorption. Most of the vinyl chloride absorbed is eliminated by the body within one day, although some of the products it is changed into will take longer to be excreted.

Short-Term (Acute) Effects

Inhalation of high levels of vinyl chloride by workers has caused central nervous system depression resulting in symptoms such as dizziness, headaches, disorientation, euphoric mood, drowsiness, and visual or hearing disturbances. A number of animal species exposed by inhalation to relatively high levels of vinyl chloride had significant damage to the liver, lungs and kidneys.

Long-Term (Chronic) Effects

Occupational exposure studies have demonstrated that workers whose jobs expose them to very high concentrations of vinyl chloride have an increased incidence of several symptoms including coldness, loss of feeling, and lessened blood flow to the fingers, decreased elasticity and thickening of the skin of the hands, and disintegration of bone at the tips of the fingers. These conditions are believed to be related to immune system dysfunction. Furthermore, studies of exposed workers' immune systems detected several differences compared to those not exposed to vinyl chloride.

Occupational studies have also detected increases in several indicators of liver dysfunction. Animal studies have confirmed injury to the liver from long term inhalation exposure to vinyl chloride at concentrations equal to or greater than 100 ppm.

Several occupational studies have observed apparent damage to the peripheral nervous system with symptoms of tingling, numbness, weakness, and feelings of warmth, most often occurring in the hands and feet.

Carcinogenic (Cancer-Causing) Effects

There is evidence that some of the breakdown products of vinyl chloride metabolism in the body can interact with genetic material of cells, resulting in permanent changes if these cells can reproduce. After many years, altered cells may develop into cancer.

Several studies of occupationally exposed workers provide solid evidence that inhalation exposure to vinyl chloride increases the incidence of a rare type of liver cancer known as angiosarcoma. Other types of cancer that were also higher in some of the worker studies included those of the brain, central nervous system, lung, lymph, and bone marrow.

Carcinogenicity studies with animals exposed by inhalation have resulted in cancer of the liver, lung, brain, mammary glands, kidney, and blood. Animal studies with oral exposure to vinyl chloride had increases in both liver angiosarcomas and other types of liver cancer.

Human studies have strongly associated exposure to vinyl chloride with increased cancer incidence. Therefore, vinyl chloride, classified by the EPA in Group A, "known to be carcinogenic to humans" under the old cancer guidelines, has been categorized as "carcinogenic to humans" by the current guidelines.

Because there is evidence from animal studies that those exposed when young are more sensitive than adults to the carcinogenic effects of vinyl chloride, there are separate estimates of cancer potency for each age group. Exposure to vinyl chloride beginning early in life is considered to double the cancer risk compared to exposure beginning in adulthood (see "Health Standards and Criteria" section).

Reproductive/Developmental Effects

In two studies, female workers exposed to vinyl chloride were found to have increased incidence of elevated blood pressure and edema when pregnant.

A decrease in fertility of male rats was observed after inhalation exposures for about three months to 250 ppm of vinyl chloride. Longer term exposure to vinyl chloride in male rats has caused testicular abnormalities.

In pregnant mice exposed to 500 ppm vinyl chloride by inhalation, toxic effects to the fetus included decreased weight, reduced litter size, and retarded development of the head and ribs.

Health Standards and Criteria

The EPA has established a maximum contaminant level goal (MCLG) of zero parts per billion (ppb = micrograms per liter or ug/l) for vinyl chloride in public drinking water systems. MCLGs are health-based non-enforceable guidelines and have traditionally been set at zero for "known" and "probable" human carcinogens. The EPA has also established a maximum contaminant level (MCL) for vinyl chloride. MCLs are enforceable drinking water standards determined by balancing the adverse health effects of a particular chemical against the feasibility and costs of treating contaminated water. The MCL for vinyl chloride is 2 ppb.

Because vinyl chloride exposure is known to cause cancer in humans, there may be some degree of carcinogenic risk even below the MCL. Based upon recent information of vinyl chloride's carcinogenic potential, the EHP estimates that drinking water containing two ppb vinyl chloride would be associated with an increased lifetime risk of cancer for adult exposure of four in 100,000 (four excess cancer cases in 100,000 people exposed). The lifetime cancer risk approximately doubles to that of eight in one hundred thousand for exposure that begins early in life. These risk estimates are based on a daily intake of two liters of water per day for 70 years.

The EPA has developed a toxicity value for non-cancer effects, known as a "reference dose" or RfD, based on an animal study in which exposure to vinyl chloride was from food. Toxicity to the liver was the most sensitive non-cancer effect. The adult drinking water equivalent level for this RfD is a vinyl chloride concentration in water of approximately 100 ppb.

The Occupational Safety and Health Administration enforceable standard, a permissible exposure limit or PEL, for vinyl chloride in workplace air is one ppm averaged over eight hours.

Suggested Reading and References

Casarett and Doull's Toxicology: The Basic Science of Poisons, Sixth Edition. Klaassen, C.D., ed. McGraw-Hill Publishing Co., Inc., New York, 2001.

Toxicological Profile for Vinyl Chloride (Draft Update). Agency for Toxic Substances and Disease Registry (ATSDR). Atlanta, Ga. July, 2006.

Toxicological information on vinyl chloride. Integrated Risk Information System (IRIS). U.S. EPA, Office of Health and Environmental Assessment. Last significant revision: September, 2000.

Toxicological Review of Vinyl Chloride. In support of summary information on the Integrated Risk Information System (IRIS). U.S. EPA, Office of Solid Waste and Emergency Response. May, 2000.